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A NEW DEEP-SEA LEECH, *BATHYBDELLA SAWYERI*, N. GEN., N. SP., FROM THERMAL VENT AREAS ON THE GALÁPAGOS RIFT

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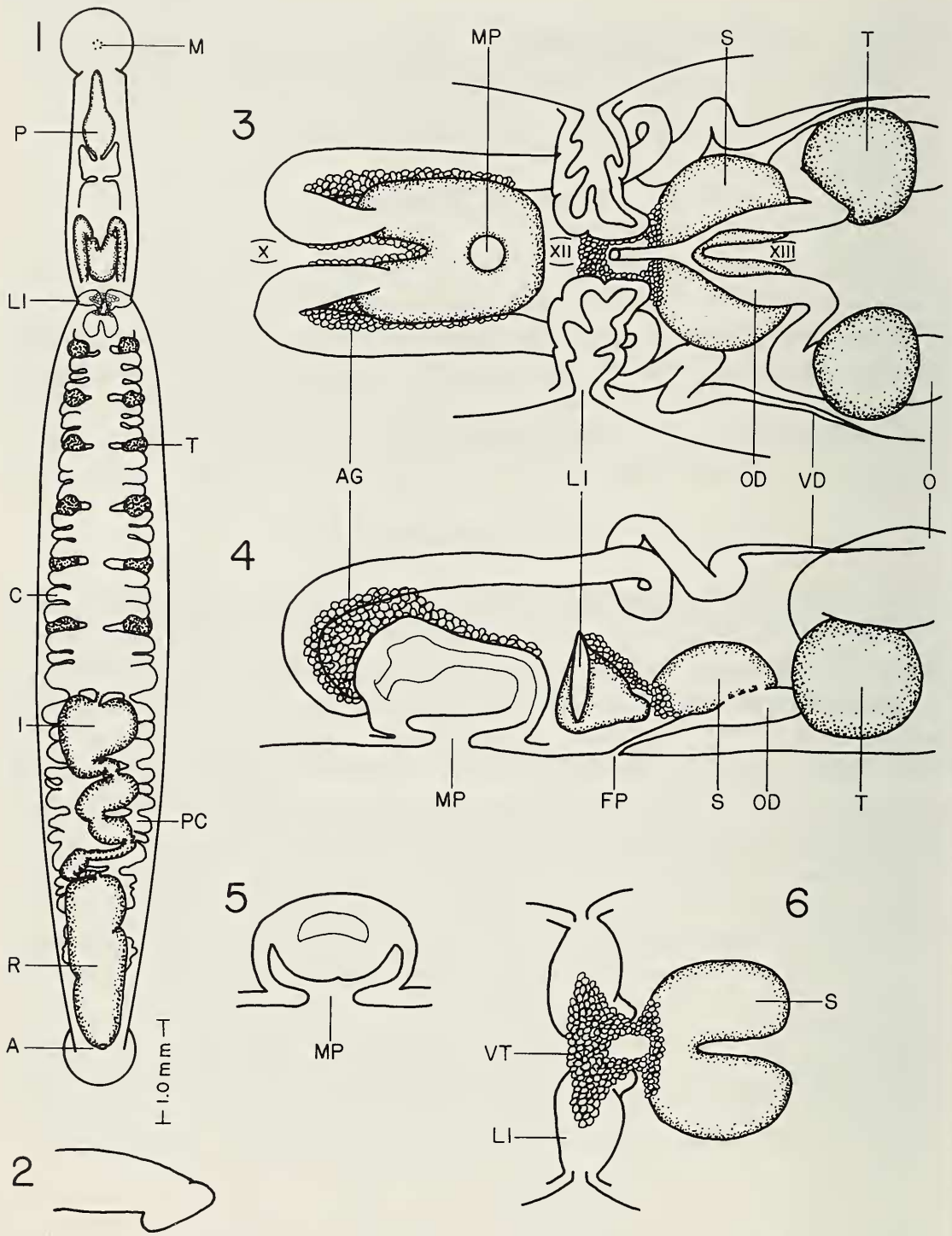
Abstract.—*Bathybdella sawyeri* was common in samples of invertebrates collected by DSRV *Alvin* from 2400 meters at 00°48.3′N, 86°13.5′W during February 1979. The leech is not known to exceed 11 mm in length and has the following morphological characteristics: tegument smooth, lacking gills and pulsatile vesicles; eyes and ocelli absent; caudal sucker small; 6 pairs of testisacs; deep, paired lateral invaginations in XII connected via vector tissue to large bilobed spermatheca in XII; postceca present.

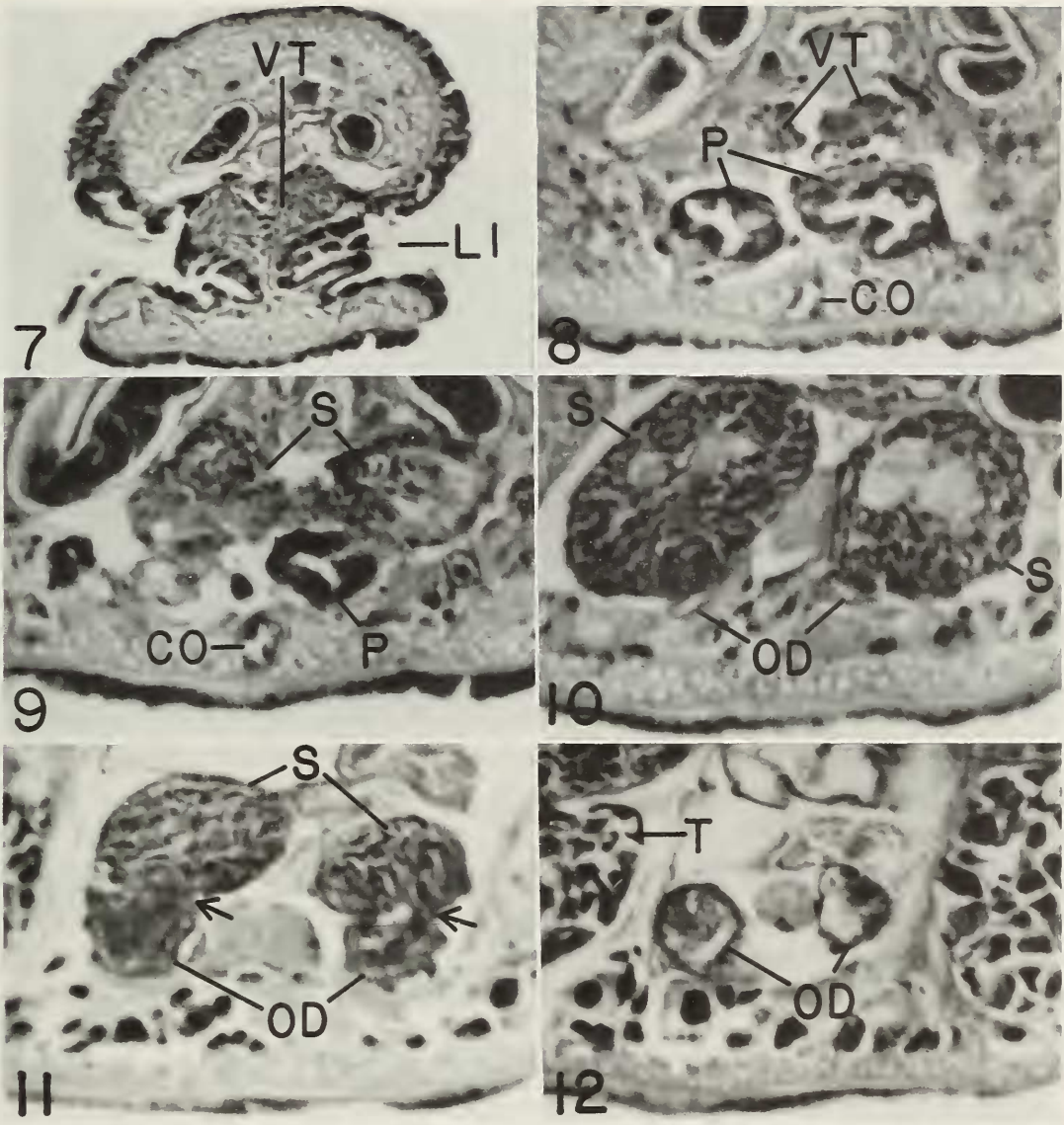
The discovery of unique biological assemblages near submarine thermal vents during the first DSRV *Alvin* expedition to the Galápagos Rift in 1977 (Corliss and Ballard, 1977; Lonsdale, 1977; Corliss et al., 1979) inspired the Galápagos Rift Biology Expedition in early 1979 (Ballard and Grassle, 1979; Grassle et al., 1979). Included in the material collected on this expedition was a small species of piscicolid leech. None of the specimens collected was from a fish, but the crop of most individuals was filled with red blood cells indicating that the leech is a fish parasite. Specimens examined include 10 individuals preserved in situ on the outer surface of a single vestimentiferan tube collected on *Alvin* dive 884 (00°47.7′N, 86°07.7′W, 2482 m, 2°C, 25 January 1979), and 46 specimens, ranging from 3 to 11 mm in length, from the bottom of a small aquarium used to temporarily hold a clump of mussels collected on *Alvin* dive 890 (00°48.3′N, 86°13.5′W, 2447 m, 2°C, 15 February 1979). Five individuals were sectioned (frontal, entire ×2; sagittal, entire; transverse, entire; transverse, anterior half), two wholemounts were prepared and stained with Semicohn's acetocarmine, and two specimens were prepared for examination under the scanning electron microscope.

Bathybdella, new genus

Diagnosis.—Size small, not known to exceed 11 mm; body elongate, cylindrical; paired deep, lateral pits in XII giving appearance of distinct trachelosome/urosome division; tegument smooth, lacking papillae, tubercles, gills, and pulsatile vesicles; caudal sucker slightly subterminal, not wider than maximum body width; oral sucker well developed; midbody segments 3(9?) annulate; crop strongly compartmented, postceca present; intestine



Figs. 1–6. *Bathybdella sawyeri*: 1, Reconstruction of digestive system, reproductive system, body shape and sucker shape from dorsal aspect; 2, Caudal sucker, lateral view; 3, Male and female reproductive systems, ventral view; 4, Male and female reproductive systems, lateral view; 5, Transverse section of terminal portion of male reproductive system at level of male gonopore; 6, Spermatheca system, dorsal view. A, anus; AG, accessory gland cells; C, crop cecum; FP, female gonopore; I, intestine; LI, lateral invagination; M, mouthpore; MP, male gonopore; O, ovisac; OD, oviduct; P, proboscis; PC, postceca; R, rectum; S, spermatheca; T, testisac; VD, vasa deferentia.



Figs. 7–12. Transverse paraffin sections of *B. sawyeri* illustrating female reproductive system. 7, ×75; 8–12, ×110. 7, Immediately posterior to ganglion in XII showing large lateral invaginations, LI, and mass of vector tissue, VT; 8, Posterior portion of XII, ventral ⅔ of body, illustrating cords of vector tissue, VT, posterior extensions of lateral invaginations, P, and common oviduct. CO; 9, Anterior portion of XIII showing bilobed spermatheca, S, with connecting element, terminal portion of posterior extension of left lateral invagination, P, and common oviduct, CO; 10, Anterior portion of XIII with paired oviducts, OD, in contact with ventral portion of spermathecal lobes, S; 11, At ganglion in XIII showing enlarged oviducts, OD, packed with sperm, and connections (arrows) between oviducts and spermathecal lobes, S; 12, Posterior portion of XIII illustrating oviducts, OD, and testisacs, T.

lacking symmetrical diverticula; 6 pairs of testisacs; bursa moderately large; deep, paired lateral invaginations immediately posterior to ganglion in XII opening externally into lateral pits; posterior margins of invaginations covered by vector tissue with short, paired cords leading to large bilobed sper-

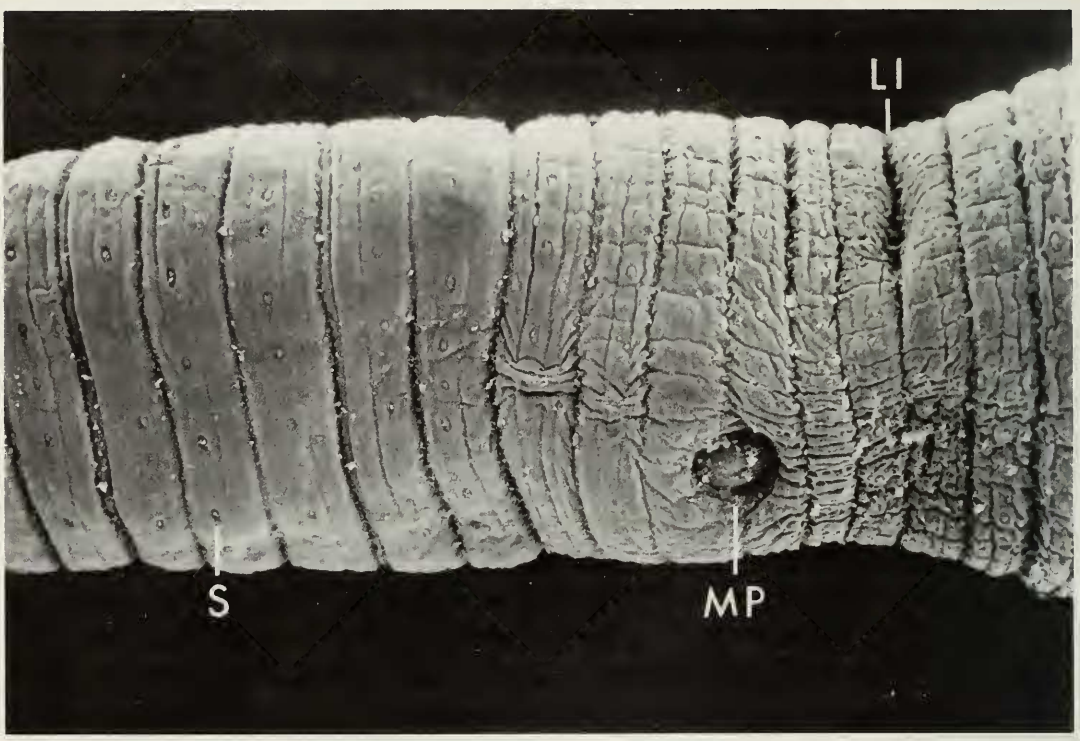


Fig. 13. Scanning electron micrograph of *B. sawyeri,* ×120. LI, lateral invagination; MP, male gonopore; S, sensillae.

matheca (seminal receptable) in XIII; oviducts in contact with ventral surface of spermatheca; marine.

Type-species.—*Bathybdella sawyeri* n. sp.,

Etymology.—From the Greek, *bathy,* deep + *bdella,* a leech.

Bathybdella sawyeri, n. sp.
Figs. 1–13

Diagnosis.—With the characters of the genus; average total length of mature individuals including suckers, 8 mm (range 6–11 mm); no eyes or ocelli on either sucker or on body; no pigmentation apparent on body or suckers; minute sensillae dorsally and ventrally on primary annuli of each segment on trachelosome and urosome; mouthpore centrally located in oral sucker; posterior portion of proboscis bulbous; esophageal diverticula absent; crop ceca trilobed; postceca fused with 4 wide fenestrae; intestine sinuous with small chambers, rectum large; accessory gland cells covering dorsal portions of ejaculatory ducts, artrial conua and bursa; bursa confluent ventrally with specious cavity opening through large male gonopore.

Holotype.—USNM 65773; *Paratypes.*—USNM 65774, 65775.

Type-locality.—Galápagos Rift, Eastern Pacific Ocean, 00°48.3′N, 86°13.5′W, 2,447 m.

Hosts.—Unknown, but assumed to be deep-sea demersal fishes.

Etymology.—Named in honor of Dr. Roy T. Sawyer in recognition of his many contributions to hirudinology.

External characters (Figs. 1, 2, 13, measurements of holotype).—Body elongate, cylindrical, and indistinctly divided into trachelosome and urosome, although deep lateral pits at ganglion in XII giving appearance of distinct separation. Average total length of mature individuals including suckers 8.0 mm (range 6–11 mm, holotype 9.0 mm). Mouthpore centrally located in well-developed discoid oral sucker 0.8 mm in diameter eccentrically attached to trachelosome. Oral sucker devoid of eye spots and pigment. Trachelosome tapering slightly toward anterior end where first 2 nuchal annuli constricted. Lateral margins otherwise roughly parallel except for deep lateral pits at level of ganglion in XII where invaginations open externally. Trachelosome width here narrowing to 0.5 mm (Figs. 1, 13). Posterior to lateral pits trachelosome widening abruptly into prominent shoulders, especially when crop is full, and merges with urosome. Male gonopore a large spherical opening 0.1 mm in diameter (Fig. 13) separated by 3 annuli from openings to invaginations in lateral pits (Fig. 13). Female gonopore never observed with certainty even under scanning electron microscope, but based upon sectioned material should be in same annular furrow as lateral invaginations or slightly caudad. Urosome widest (1.3 mm) at midlength of body and tapering to 0.7 mm at caudal sucker, lacking papillae, tubercles, gills, pulsatile vesicles, pigment and ocelli. Midbody segments basically 3-annulate, each deeply furrowed primary annulus further subdivided such that there appear to be 3 or 4 secondary annuli in each primary annulus. Minute sensillae (Fig. 13) dorsally and ventrally on each primary annulus of urosome and trachelosome. Caudal sucker small (0.8 mm diameter), slightly subterminal, not wider than greatest body width, and lacking pigmentation and ocelli.

Coelomic system.—Material inadequate for detailed characterization. Lateral extensions of ventral sinus at ganglia and of dorsal sinus intersegmentally in testicular region. Presence of lateral sinuses unconfirmed. Pulsatile vesicles absent.

Central nervous system.—Central nervous system typical of that of other piscicolid leeches with ventral nerve cord consisting of anterior ganglionic mass, 21 segmental ganglia in VII though XXVII, and posterior ganglionic mass.

Digestive system (Fig. 1).—Mouthpore approximately centrally located in oral sucker. Proboscis, 530 μm in length, extending to ganglion in IX; anterior portion about 100 μm in diameter, expanding somewhat abruptly about mid-length into bulbous portion 210 μm in diameter (Fig. 1). Bulbous portion appearing too large to pass through anterior ganglionic mass, unless quite compressible. Salivary glands located between ganglia in VII and IX. Crop divided into 2 compartments in trachelosome; first with 2 short anterior

projections around base of proboscis. No esophageal diverticula present. Crop lumen expanding between testisacs into large trilobed ceca (Fig. 1). Intestine and postceca originating immediately posterior to ganglion in XIX. Intestine a large chamber with short anterior pouches at XIX/XX, narrowing abruptly at ganglion in XX, becoming tubular, sinuous, with small pouches in anterior portion of XX, XXI and XXII, the latter displaced laterally to left. Intestine entering a large, uniformly tubular rectum at XXIII/XXIV. Posteca fused with 4 wide fenestrae immediately posterior to ganglia from XX to XXIII. Trilobed nature of crop persisting in postceca to XXIII; postceca terminate at XXVI.

Reproductive System.—(Figs. 4–13). Six pairs of large testisacs located intersegmentally in XIII/XIV through XVIII/XIX. Vasa deferentia enlarged in XIII and entering loosely coiled epididimides in anterior portion of XIII, continuing cephalad and becoming confluent with ejaculatory bulbs as walls of ducts become increasingly thicker and more glandular. Immediately posterior to ganglion in X, ducts bending ventrad and lumina becoming very small. Ejaculatory ducts entering atrial cornua on their anteroventral margin (Figs. 3, 4). Lumina of atrial cornua merging into small common atrium which opens into moderately large bursa. Bursa continuing caudad to near ganglion in XII, bending ventrad and entering a spacious chamber between body wall and elongated glandular mass of atrium (Figs. 4, 5). This chamber opening externally through large male gonopore in anterior portion of XII. Region between ventral surface of ejaculatory bulbs and dorsal surface of ejaculatory ducts, atrium and bursa covered with large mass of accessory gland cells (Fig. 3, 4).

Female system having paired, deep, lateral invaginations immediately posterior to ganglion in XII (Figs. 3, 4, 6). Openings to invaginations appearing externally as long vertical slits (Fig. 13) in lateral depressions or pits. These invaginations being spacious, epithelial-lined cavities penetrating almost to midline of body (Figs. 3, 7). Posterior projections from each invagination terminating near anterior margin of large, bilobed spermatheca (Fig. 9) located in anterior portion of XIII (Figs. 3, 4, 8, 9). Compact mass of vector tissue covering dorsal and posterior margins of each lateral invagination and filling area between them (Figs. 6, 7). Vector tissue narrowing abruptly and bifurcating into 2 short cords of cells prior to merging with lobes of spermatheca at XII/XIII (Figs. 6, 8). Vector tissue cords without lumina or surrounding epithelium. Spermatheca, situated in anterior portion of XIII, consisting of 2 broadly elongate lobes with a narrow anterior connection. Spermatheca a loose cellular mass bounded by an epithelium except at extreme anterior portion where a proliferation of vector tissue cord cells not covered by an external epithelium (Fig. 6). Unlined cavity present in each spermatheca lobe (Fig. 10). Sperm present in spermatheca of all sectioned leeches, but never present in lateral invaginations.

Ovisacs situated dorsally at XIII/XIV. Left and right oviducts bending ventrad near first pair of testisacs and continuing anteriorly near body midline (Fig. 12). Oviducts, when contacting ventral surface of spermatheca, expanding and filled with sperm (Figs. 3, 11). In sectioned material, epithelium of dorsal surface of oviducts and ventral surface of spermatheca becoming diffuse such that there are many places where lumina of oviducts are confluent with spermatheca and sperm can be seen in the process of entering oviducts (Fig. 11). Oviducts continuing cephalad, still in contact with spermatheca, then becoming very small tubes (Figs. 3, 10). Oviducts eventually fusing into common oviduct then bending ventrad and cephalad to female gonopore somewhat posterior to lateral invaginations (Figs. 4, 8, 9).

Discussion

Bathybdella sawyeri is remarkable for depth of collection, abundance, and the unique anatomy of the female reproductive system. The depth of collection is exceeded only by *Galatheabdella bruuni* from 4400 m and 3880 m in the Tasman Sea (Richardson and Meyer, 1973), and by an unidentified leech from the deep-sea fish *Bassozetus* from 3570 m in the Pacific off Costa Rica listed in the same report. It is likely that the latter leech is *Bathybdella sawyeri*. The collection location (9°23′N, 89°32′W) is near the Galápagos Rift region and the brief description provided by Richardson and Meyer (1973), from a single poorly preserved specimen, resembles that of *B. sawyeri*. This suggests that *B. sawyeri* may not be endemic to vent areas, but rather may be a parasite of widely distributed deep-sea benthopelagic fishes such as *Bassozetus*. The unusually high abundance of the leech in vent areas may be the result of an abundance of fish hosts attracted by a rich food supply, and also the presence of hard substrate for cocoon deposition. According to Cohen (pers. comm.) approximately 16 species of mainly benthopelagic fishes have been photographed, observed, or captured in the thermal vent areas. Most, including *Bassozetus,* are rare, but some Macrouridae (benthopelagic) and two species of Zoarcidae (secretive, sedentary benthic fishes) are apparently common in the vent area.

Bathybdella sawyeri has one of the most complex arrangements known in the Piscicolidae for conducting spermatozoa from the external copulatory zone near the gonopores to the ova. The spermatozoa are apparently introduced into or near the lateral invaginations, migrate through the epithelial layer of the invaginations to the surrounding vector tissue, and then along the narrow cords to the spermatheca where they are stored until they pass into the oviducts. Neither copulation nor attached spermatophores have been observed in *B. sawyeri,* however, and it is not known how, or for certain if, spermatozoa enter the lateral invaginations. An unpaired ventral invagination, histologically identical to those of *B. sawyeri* and surrounded

by vector tissue, occurs in *Mysidobdella borealis* (Johansson). This structure often contains spermatozoa and was termed a spermatheca by Burreson and Allen (1978). It is unlikely that the lateral invaginations in *B. sawyeri* function as spermathecae since other structures serve that purpose, and thus the histologically identical invagination in *M. borealis* may not function as a spermatheca either. These deep pouches probably hold the spermatozoa only temporarily. A deep, ventral invagination and a shallow ventral depression are reported by Brumpt (1900) in *Branchellion torpedinis* and *Cystobranchus respirans* respectively. While it may be tempting to interpret these invaginations as relict structures derivable from the paired ectodermal spermathecae of oligochaetes, it is also possible that they are advanced characters derived by invagination of the piscicolid copulatory zone into the ventral vector tissue mass. The true spermatheca in *B. sawyeri* is similar histologically and in segmental position to those of other piscicolids but has unique features as well. It is strongly bilobed whereas in most piscicolids spermathecae (used in the broad sense of any large well-defined mass of vector tissue) are unpaired. These include *Marsipobdella sacculata* Moore, *Hemibdella soleae* Van Beneden & Hesse, *Johanssonia arctica* (Johansson), *Calliobdella vivida* (Verrill), and *Piscicola salmositica* Meyer, among others. However, the basic bilateral nature of the spermatheca in other species may be reflected by the paired cords of conductive tissue from the spermatheca to the ovisacs present in *H. soleae, C. vivida, P. salmositica,* and others. The primitive leech, *Acanthobdella peledina* Grube does have a bilobed spermatheca in XIII and, interestingly, a shallow ventral invaginated pit at XII/XIII (Brumpt, 1900). The most unique feature of the spermatheca in *B. sawyeri* is its position dorsal to the oviducts. In all other piscicolids the spermatheca or vector tissue mass is situated ventral to the ovisacs, immediately behind the female gonopore, and closely associated with the copulatory zone of the ventral body wall. This facilitates transfer of spermatozoa from spermatophores affixed to the copulatory zone to the spermatheca. In such arrangements the oviducts usually pass through the anterior portion of the spermatheca. Even in *Marsipobdella sacculata* the elongate, more dorsally situated spermatheca terminates in vector tissue near the ventral body wall posterior to the female gonopore. In *B. sawyeri* the spermatheca is located more in the middle of the body away from the ventral body wall.

The closest relatives of *Bathybdella* n. gen. may be *Mysidobdella* Selensky and *Hemibdella* van Beneden and Hesse, although neither is really very similar. *Mysidobdella* has a single deep invagination bordered by vector tissue (Burreson and Allen, 1978), but it is located posterior to the female pore in XIII while those of *B. sawyeri* are anterior to the female pore in XII. *Hemibdella* possesses a spermatheca and accessory gland cells around the atrium and lacks eyes and ocelli (Selensky, 1931). *Mysidobdella* and

Hemibdella are both small marine leeches with small caudal suckers, but, unlike *B. sawyeri*, both have only five pairs of testisacs.

The combination of paired, lateral invaginations; bilobed spermatheca dorsal to the oviducts; six pairs of testisacs; small caudal sucker, and lack of pulsatile vesicles clearly separates *Bathybdella* from all other previously described genera.

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